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of the

Research and Educational Activities

in

Machine Computation

by the

Cooperating Colleges of New England

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Computation Center
Massachusetts Institute of Technology
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I. RESEARCH ACTIVITIES

1.1 Development of the Experimental Time-Sharing System

F.J. Corbató
M.M. Daggett
R.C. Daley
R. Creasy

During the last six months, work was continued on the time-sharing system which was described in the previous report. This system was first publicly demonstrated with two typewriters in November 1961, on the 709, and has since been converted to the 7090 after a six months' delay due to hardware conversion difficulties. This working system was reported on in a paper[1] delivered at the Spring Joint Computer Conference in May 1962. During this period, future planning and refinement of the system has progressed and anticipation of the IBM 1301 disk memory has begun. A master disk supervisor program has been specified as well as plans for complete memory protection using the RPQ feature developed for the 7090 at the Computation Center.

1.2 Real-Time, Time-Shared Computer Project

H.M. Teager
B.W. Munday
M. Kudlick
A. Rutchka
E. Kliman

Work over the past six months has continued in all phases of this project, ranging from devices through software, in the areas of graphical inputs, graphical outputs, problem- and procedure-oriented languages, and the scheduling and allocation of a central processor with backup temporary storage devices.

I. Hardware

With respect to hardware and equipment, three on-line Flexowriters and a photoelectric tape reader have been connected to a new transistorized rack and are operating satisfactorily. The special-purpose, plotter control computer and three on-line plotters are still not satisfactory with respect to reliability, the primary difficulties centering in the associated disc storage unit.

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[1] F.J. Corbató, M.M. Daggett, R.C. Daley, "An Experimental Time-Sharing System", Proceedings of the Spring Joint Computer Conference, May 1962.

A principle for a graphical input device, capable of operating in real-time with a special "pencil" and ordinary paper, had been found. The principle involved recognition of a stylus position by means of coded sequences of current pulses in a matrix of conductors below the plane of the paper. Experimental and theoretical work at that time indicated that the principle was sound, and has been confirmed by the performance of a full-scale device at another institution. As envisioned, the device would incorporate slope detection facilities (quantized into octants), and thus, if desirable, point information could be recoded into line segment information for easier computer assimilation. It would also be linked to a graphical output device (for feedback purposes) by means of a common supply of paper. Prototype development of this device has necessarily lagged due to other, more urgent problems, and all ramifications of this basic capability have meanwhile had to be considered in terms of its design characteristics, rather than actual measured performance.

II. Graphic Input

Recognition of a wide range of hand-printed characters is not a pre-condition for a feasible graphical language. Such characters can also be entered into a computer via a keyboard, once their position on the surface has been located by the pencil. It is, however, an interesting problem in its own right, particularly since a much wider class of symbols in theory can be produced by hand than with a keyboard, with seemingly less distraction and attendant disruption of the user's attention. Also, since the graphical input device planned had characteristics which essentially eliminated the scanning problem, and the graphical output device could provide a necessary corrective feedback for error or uncertainty, it was felt that input of hand-drawn characters might be feasible without too many restrictions on the user. Test results indicate that block-printed characters can, with a high degree of reliability, be identified without requiring either excess memory space or machine time, so long as the carefully-drawn input is correlated with a particular user's set. The approaches that proved successful with alphameric fonts of block-printed characters proved insufficient for the more subtle variations associated with larger, mixed fonts of cursive characters, and a broader approach encompassing both extremes has been derived. This new approach, while not yet reduced to software, has been simulated with experimental data and found to lead to results which should be quite adequate for a system with graphical feedback to resolve any uncertainties in identification. In the process, a much more stringent analysis has been made of the relationship between the appearance of symbols and the process of making them, as well as the limitations of an arbitrarily large and unrestricted font of characters.

III. Software

Graphical languages are generally more of a convenience to the human operator, rather than an advantage for the machine. In addition to the problem of converting from a graphical description into a machine

II. EDUCATIONAL ACTIVITIES

2.0 Introduction

As an educational organization, the Computation Center has been continuing its efforts to develop more comprehensive and effective computer usage, and to stimulate the interest of potential users. These activities fall into three broad areas: courses, general services, and the IBM Research Appointment Program.

2.1 IBM Research Assistants and Associates

Under the Research Assistant program, selected students continue to extend their programming skills with the supervision of the Computation Center staff. To develop experience with techniques and applications, special projects have been assigned, concerning problems such as the upkeep and development of the FMS system, operation of the Center, research on new monitor systems, and Center projects such as time-sharing. Students are encouraged to learn techniques relevant to their own fields and are given guidance on individual research when possible. Research Assistants also do a considerable amount of consulting for members of their own departments, a service which is especially valuable since they combine knowledge of the particular field with experience in programming and procedures.

The Research Associate program provides people doing research in many fields with the opportunity to apply computer techniques to their research. Moreover, general interest and proficiency in the use of computer and computational techniques have been greatly increased by the Research Associate program. Almost everyone involved has included computer technique in their courses when applicable, and given courses in machine computation. They have also lectured to outside groups, and many Assistants and Associate have held seminars to generate interest within their own departments. In the past few years, small computers have been installed at many of the New England Colleges and Universities. Research Associates have been instrumental in setting up and administrating these local installations, which are generally used to supplement the 7090 by handling elementary course work, running simple programs and doing preliminary work on problems intended for the 7090.

2.1.1 Progress Report of Mr. Gay L. Carley, Department of Electrical Engineering, MIT

Two important things have been accomplished in the effort to develo a skillful bridge-playing program for the 7090: 1) A program which plays acceptable, but not outstanding bridge has been developed; 2) A large complex of bridge-oriented subroutines now exists, forming a "language" with which new strategy ideas may be quickly turned into a working program. It is hoped that this framework may be of use to others interested in programming bridge. In the present program, the bidding is quite weak. This is because an extremely sophisticated bidding program is well under way, and it was deemed undesirable to spend much effort on an intermediate version. The weak bidding system is able to count Goren points and make elementary partnership considerations.

The present play routine runs some 3000 FAP instructions and plays quite respectably. It is essentially a long list of rules-of-thumb. A typical rule: Defender, can follow suit, third card to trick, second card high, probability the trick can be won in this hand is more than .6: play lowest winner. The programming has been kept very flexible so that a major change in strategy could be made with a minimum of wasted or duplicated work. This has resulted in more than 60 subroutines, only a few of which involve any commitment to strategy.

In addition to the bridge program itself, a program is being developed which allows the bridge program to simultaneously play a game from tape and a game on-line. This should save considerable machine time. Another program is being developed to effeciently pack BCD cards onto binary cards. By using variable length code-words and binary-coded-trinary blank counting, an average packing efficiency of 10:1 or better is expected. Illegal (binary) punched columns are reproduced properly.

2.1.2 Progress Report of Mr. Michael Kudlick, Department of Mathematics, MIT

The scheduling program for the allocation of memory space and running time to user programs has been completed during the period covered since the last report. The method used allows one to three programs to share space in core storage with the scheduling program; the memory-protect mode provides the necessary safeguards against improper usage of storage instructions by any of the user programs. Only one of the three programs is actually being executed by the machine during a given time interval. Concurrently, however, the input-output channel is able to read the next program to be run into its allotted space and then write out the program which was previously run. In this way the transition from the current running program to the next running program is simple and relatively free from input-output delays.

A scheme for recognizing a single word of BCD information has also been coded and checked out during the period since the last report. This method substitutes an easily computable number for each BCD word to be recognized, and hence is similar to a random-access storage scheme. However, the number which is computed is not unique; its purpose is to reduce the amount of table-lookup needed to determine the meaning of the word by providing a smooth numerical distribution of the alphabetic information

M2015 MODEL OF EDDY DIFFUSION ACCOMPANIED BY FIRST ORDER IRREVERSIBLE CHEMICAL REACTION

Wolf Randolph Vieth, Chemical Engineering

A problem of considerable interest to the chemical engineer is the prediction of the effect of a chemical reaction on the rate of absorption of a gas by a liquid. This problem has been treated analytically, one approach assuming that molecular diffusion and chemical reaction occur in a thin stagnant liquid film adjacent to the gas-liquid interface, and the effect of the reaction on the over-all mass transfer coefficient has been calculated. The present study represents an extension of this work, taking into account the effect of turbulence in the flowing liquid, which causes bulk or eddy motion, even in the very thin layer of liquid near the gas-liquid interface. Consideration of this additional transport mechanism may lead to the prediction of larger over-all mass transfer coefficients than calculated from film theory. Mathematical analysis of the model leads to an ordinary second order differential equation with variable coefficients. A SHARE computer program is available for the solution of this problem.

M2016 BRIDGE

Bruce Knobe, Mathematics

The object of the program is to bid and play a game of bridge. To simplify the situation, the computer will play all four hands. The bidding system will be modified Goren. It will stress the point count system of evaluating a hand to the utmost. The playing, which is my main interest, will work on a probablistic analysis of the data, both that obtained from the bidding and that obtained from the cards the computer can see. At any time the computer will make the play that will give it the highest expectation of making or setting the contract, as opposed to making the most tricks.

M2017 TRANSPORT IN CYLINDRICAL RODS

K. Bingham Cady, Nuclear Engineering

Boltzmann's linear integral equation for one velocity neutrons with isotropic scattering is considered in cylindrical rods. Certain standard problems are to be solved by a variational method giving simultaneous linear equations. The computer will be used to solve these equations and do other arithmetical calculations.

M2018 EARTHWORK CONSTRUCTION COMPANY SIMULATION

Joseph S. Keller, Building Engineering and Construction

Individual construction companies are characterized by wide fluctuations in employment, equipment utilization, and work in process, which in turn affect profit margin and thereby aggregate profit. An earth work construction company has been selected as a typical example of a company confronted with these oscillations and has been placed in a competitive environment. The problem consists of finding the causes of the above noted fluctuations, and therefrom a means of reducing or eliminating these fluctuations. The techniques of modeling and simulation will be used with particular attention to the effects and implications of feedback and the analysis of same.

M2019 EUROPEAN ELITE STUDY

Daniel Lerner, Economics

An extensive study of the attitudes of elite in France, Great Britain, and West Germany has been made under the sponsorship of the Research Program in International Communication, Center for International Studies, M.I.T., and the Institute for European Studies, Paris. The study, begun in 1954, has investigated the changing response of the elites to the problems of European unification. Portions of the remaining analysis are to be carried out by graduate students in a research seminar on international communications. Use of the computer for data reduction and statistical analysis will increase the range of study and eliminate large amounts of routine work.

M2020 JOB ALLOCATION

Alain Bloch, Electrical Engineering

This problem is an extension of the classical allocation problem where a certain number of jobs have to be allocated on a given population of machines.

We suppose furthermore that we will associate a fixed cost with each machine to be used, and we will allow a certain flexibility in the requirements so as to provide an optium solution, taking into account the uncertainty in sales forecast. The mathematical technique used to solve the problem is the "cutting planes" method for all-integer programming problems due to Gomory.

VI. PUBLICATIONS OF THE CENTER

6.0 Computation Center Memoranda

Computation Center Memoranda are identified by the letter designation CC. Although certain Computation Center Memoranda are for internal circulation only, there are others which are of specific interest to all 7090 programmers at the time of printing. The following are available on request as long as the supply lasts.

CC-173	Linking Segment System Description and Use Within the FMS System, J. McCarthy, F.J. Corbató, M.L. Merwin, and R. Daley, February 16, 1961 (8 pages).
CC-174-1	Description of a 7090 FAP version of XSIMEQF, XDETRMF, A.M. Neill, June 1962 (6 pages).
CC-176-1	Octal Correction Cards Within the FMS System, R. Daley, July 1962 (3 pages).
CC-178	Availability of COMIT, V. Yngve, June 22, 1961 (2 pages).
CC-180-6	Computation Center Version of the FORTRAN-FAP Monitor System, J. Spall, July 1962 (4 pages).
CC-181	The Use of MAD in the MIT Version of the FMS System, L. Korn and M. Merwin, December 13, 1961 (3 pages).
CC-182-1	Common Programming Errors, Consulting Staff, March 1962 (7 pages)
CC-183	General Description and Instructions for the Use of the Time-Sharing Console, M. Kovarik and A. Rutchka, October 4, 1961 (7 pages).
CC-185	An Experimental Time-Sharing System for the 709, F.J. Corbató, M.L. Merwin, and R. Daley, November 28, 1961 (5 pages).
CC-186-2	FORTRAN and MAD Format Specifications, J. Spall, July 1962 (12 pages).
CC-188	MADTRAN, A FORTRAN-to-MAD Language Translator, L. Korn, December 11, 1961 (3 pages).
CC-193	MI TMR, an FMS Subprogram for Using the IBM Interval Timer Clock, M.M. Daggett, March 1962 (6 pages).

6.1 Professional Society Papers; Seminars

During the past six months, the following papers and seminars were presented by members of the Computation Center Staff.

"An Experimental Time-Sharing System for the 7090 Computer", by F.J. Corbató, M. Merwin-Daggett, and R. Daley, presented by F.J. Corbató at the Spring Joint Computer Conference, San Francisco, California, May 1962.

"The Relationship of Computers to the High Schools", invited talk by F.J. Corbató at Boston College, April 4, 1962.

"Time-Sharing with the 7090 Computer", invited talk by F.J. Corbató at IBM Research Center, New York, June 8, 1962.

"FORTRAN is the Most Widely Used and Implemented Programming Language in the World Today, But ---", invited talk by F.J. Corbato at the Association for Computing Machinery Panel Discussion, June 26, 1962.

6.2 Participation in Professional Societies by Members of the Computation Center Staff

Dr. F. J. Corbato is a member of the FORTRAN Committee of SHARE.

Mrs. Marjorie Merwin-Daggett is a member of the FORTRAN Committee of SHARE.

6.3 Journal Articles, Published Reports, Papers Presented, and Books

See Table VI for references to material written by users of the 7090.